



***Mobile & Wireless
Forum***

FCC-MWF MTG

September 17, 2020

Agenda

- Introductions; Purposes of Meeting
- Update on Changes at the FCC
- Update on MWF Activities
- FDA Scientific Literature Review (2008-2019)
- Issues Related to Testing at 6-10 GHz
- Time Averaging Methodology and Testing
- Specific Questions
- Opportunities for Streamlining Certifications

Introduction; Purposes of Meeting

- Overarching Purpose: To maintain the ongoing dialogue between FCC and MWF
- Reintroduce MWF to OET and the Lab after changes at FCC
- Meet new FCC staff
- Update FCC on MWF research activity
- Discuss current procedures and proposals

Introduction

- The MWF is an international non-profit association of telecommunications equipment manufacturers with an interest in mobile or wireless communications.



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20 years of EMF research

- Since 1998, MWF's research mission:
 - Facilitate **joint funding** between governments, industry and international health organisations
 - Follow **WHO Research Agenda**
 - **Respond to concerns** about safety of mobile and wireless devices
 - **Transparency and peer review**
 - Require publication of **all research results** to build a **body of scientific evidence**
- Provide **high quality public information**
- Rely on **weight of scientific evidence**

Overview of MWF Research Efforts



http://www.mwfai.org/docs/eng/2018_05_MWF_20YearsofResearch.pdf

Unique Expertise of MWF

- MWF is a global body with members doing business in every country.
- MWF is uniquely situated to appreciate the importance of global alignment of certification regulations and to understand the detrimental impact of non-alignment.
- Consequently, MWF constantly strives to seek as much alignment of regulations as possible.

Update on Changes at the FCC

- Current Staff and Roles
- Procedural Changes

Update on MWF Activities

- 5G Research Program Update
- Ongoing work on health/safety/testing issue

MWF Sponsored Research

2015 – 2016: '6 GHz +' Phase 1

- Package 1: Improve dosimetric understanding at frequencies above 6 GHz
- Package 2: Develop EMF compliance testing at frequencies above 6 GHz

2016: 5G workshop at BioEM

2017 – 2018: '6 GHz +' Phase 2

- Study of correlation between incident power density and temperature elevation
- Numerical modelling & characterization of 5G mock-ups
- Time-averaging

2018: 5G workshop at BioEM

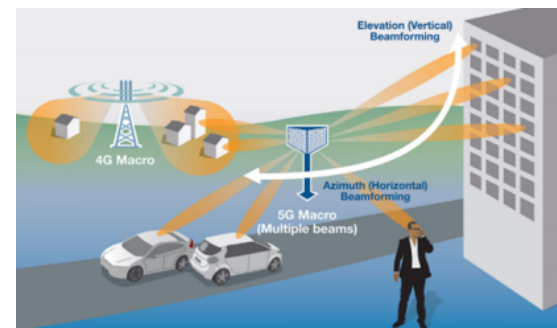
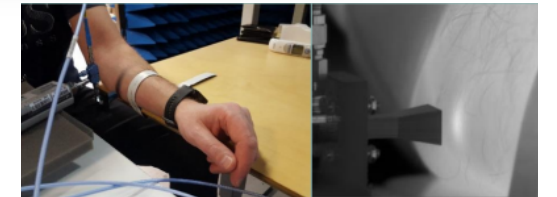
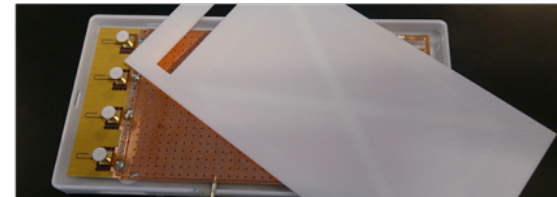
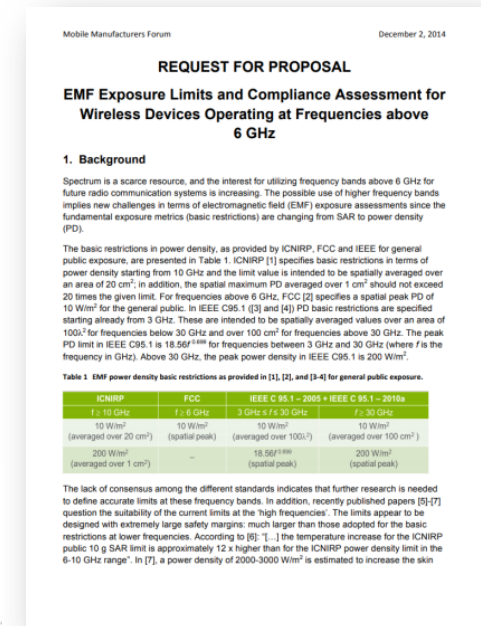
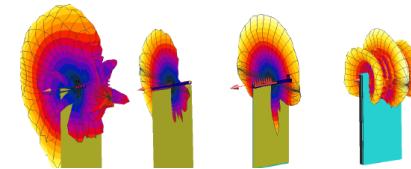
2019: 5G and '6 GHz +' Phase 3

- In-situ EMF assessments of 5G BS
- Literature review of biological effects above 6 GHz
- Efficient procedures for EMF compliance assessment of devices above 6 GHz

2020:

- Literature review of thermal models of relevance for EMF above 6 GHz
- Analysis of dosimetric systems for toxicological studies
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MWF's Contribution to 5G Research

- Program 9 “Emerging and Future Technologies”
 - Related to 5G networks and devices
 - Focussed on transition from SAR to power density
 - Dedicated to create better understanding of
 - how higher frequencies (6 to 100 GHz) are absorbed within the skin;
 - associated temperature increases; and,
 - necessary compliance testing framework for devices.

5G Research Projects

5G RESEARCH PROJECTS	OBJECTIVES
Testing 5G devices with smart antennas	Look at the skin temperature increase caused by exposure to the fields of 5G devices and establish the relationships between different types of antennas, interaction with the skin models and temperature increases.
Measuring power density	Investigate the practicality of back-propagation to calculate the power density of an RF source using 28 and 60 GHz antennas.
Power density and temperature increase	Investigate the correlation between power density and temperature increase by utilising MRI scans of participants immediately after exposure to determine the real temperature increase experienced (Underway).
Workshops at BioEM to present findings and promote discussions	As part of our program, we supported workshops in 2016, 2017 and 2018 at the BioEM conference to present findings and encourage.
In-situ measurements of 5G networks	Define in-situ measurement procedures for massive MIMO and 5G BS
Literature review of health effect studies at mmW frequencies	Review the body of research addressing bioeffects and mmW
Test reduction for 5G UE	Define criteria to improve efficiency of 5G EMF compliance testing (e.g. SAR + PD; multiple transmitters, etc)
Power density as an exposure metric	Identify the expression for power density which provides the best correlation with temperature increase and support IEEE ICES TC95 SC6 work
Numerical phantom for SAR exposure assessment in the extremities	Develop numerical phantoms suitable for SAR assessment in the extremities and support EMF compliance assessment standardization in the automotive environment

5G Research Projects (Continued)

5G RESEARCH PROJECTS	OBJECTIVES
Compliance of multiple IoT systems in a residential environment	Model and estimate RF levels in a typical IoT residential home environment and support development of IEEE 1528.7
Dosimetric understanding above 6 GHz	Suggest possible improvements of the basic restrictions at frequencies above 6 GHz for whole-body and localized exposure in terms of power density limits and related averaging areas.
Compliance testing above 6 GHz	Define compliance assessment methods and procedures to demonstrate compliance of wireless equipment with the basic restrictions at frequencies above 6 GHz. The focus was on measurements for portable devices used in close proximity of the body.
Measuring small cell exposures	Perform a study of RF EMF exposure from actual small cell access points in real world settings in several countries and different configurations
Enhancing compliance testing for 5G devices	Identify the most accurate limits and suggest possible improvements to the power density limits applicable for 5G devices operating above 6 GHz.

MWF-Sponsored 5G Research Project Publications

1. Foster, Ziskin and Balzano, "Thermal response of human skin to microwave energy: a critical review", Health Physics Journal, 2016
2. Foster and Colombi, "Thermal response of tissue to RF exposure from canonical dipoles at frequencies for future mobile communication system, Electronic Letters, 2017
3. Foster, Ziskin and Balzano, "Thermal modeling for the next generation of radiofrequency exposure limits: commentary", Health Physics Journal, 2017
4. Ziskin, Alekseev, Foster and Balzano, "Tissue models for RF exposure evaluation at frequencies above 6 GHz", Bioelectromagnetics, 2018
5. Christ, Colombi and Joyner, "Thermal Modeling of the Near-Field Exposure from Wireless 5G Devices", EuCap 2018
6. Carrasco, Colombi, Foster, Ziskin and Balzano, "Exposure Assessment of Portable Wireless Devices above 6 GHz", Radiat Prot Dosimetry, 2018
7. Foster, Ziskin, Balzano and Bit-Babik, "Modeling Tissue Heating From Exposure to Radiofrequency Energy and Relevance of Tissue Heating to Exposure Limits: Heating Factor", Health Physics Journal, 2018
8. Pfeifer, Carrasco, Crespo-Valero, Neufeld, Kuhn, Samaras, Christ, Capstick and Kuster, "Total Field Reconstruction in the Near Field Using Pseudo-Vector E-Field Measurements", IEEE EMC, 2018
9. Lundgren, Helander, Gustafsson, Sjöberg, Xu and Colombi, Near Field Reconstruction for Electromagnetic Exposure of 5G Communication Devices, Annual Meeting and Symposium of the Antenna Measurement Techniques Association, 2018
10. Colombi, Xu, Törnevik, Christ, Foster, Ziskin and Balzano, "Comparison between numerically and experimentally assessed skin temperature elevations for localized RF exposure at frequencies above 6 GHz", BioEM 2018
11. Christ, Samaras, Neufeld and Kuster, "RF-Induced temperature increase in a stratified model of the skin for plane-wave exposure at 6-100 GHz" Radiation Protection Dosimetry, 2020
12. Foster, Ziskin, Balzano and Hirata, "Thermal Analysis of Averaging Times in Radio-Frequency Exposure Limits Above 1 GHz", IEEE Access, 2019
13. Lundgren, Helander, Gustafsson, Sjöberg, Xu, and Colombi, "Near-Field Measurement and Calibration Technique for RF EMF Exposure Assessment of mm-wave 5G Devices", in publication on the IEEE Antennas and Propagation Society Magazine.
14. Aerts, Verloock, Van den Bossche, Colombi, Martens, Törnevik, Joseph, "In-Situ Measurement Methodology for the Assessment of 5G NR Base Station Exposure at Sub-6 GHz Frequencies", IEEE Access, 2019

Concluding Remarks

- The MWF spearheaded and continues to support top-notch research with the objective to ensure the availability of science-based exposure limits and of suitable EMF compliance assessment methodologies for 5G
- The outcome of the MWF research programs has been disseminated through:
 - publications in peer-reviewed journals
 - conference contributions
 - 5G-themed workshops in conjunction with BioEM
 - technical inputs through standardization (IEC, IEEE, ITU, CENELEC)

FDA Review of Scientific Literature

- The FDA recently published an update to its review of the scientific literature from 2008 to 2018 (now expanded to 2019)
 - The scope of the review includes the NTP rodent bioassays
- Overarching conclusion:

Based on the studies that are described in detail in this report, there is insufficient evidence to support a causal association between RFR exposure and tumorigenesis. There is a lack of clear dose response relationship, a lack of consistent findings or specificity, and a lack of biological mechanistic plausibility.

Measurements Straddling 6 GHz

- Issue in the UNII-5 Band, which straddles 6 GHz
- The IEC has determined to permit manufacturers to select their measurement technique – either SAR or power density for such measurements
- MWF proposes a similar approach in the U.S. to permit alignment of measurement techniques
- For power density measurements where there is a straddle, MWF proposes that we test the lowest channel wholly above 6 GHz rather than a channel below 6 GHz.

MWF's Concern about FCC's Reluctance to Adopt Current Standardized Time-Averaging Procedures

- In the time period from November 2019 to February 2020 the two principal standards bodies (IEEE and ICNIRP) promulgated scientifically-based methods for time-averaging
- The procedures set out in IEEE and ICNIRP were adopted in North America by Health Canada and ISED (below 6 GHz at this time)
- FCC has not yet adopted the IEEE/ICNIRP approach due to its concern about temporal power spikes depositing too much energy in tissue
- MWF believes these concerns are addressed under the methods in IEEE and ICNIRP

FCC's Position

“... since we do not limit temporal-peak SAR or power density, all the energy available in a time-averaging period could be deposited in a moment resulting in a well-defined temperature rise and be compliant with the rules. Thus, using the extended time-averaging periods of 6 minutes or 30 minutes set forth in our rules in other contexts or either of the alternative time windows specified by ICNIRP and IEEE could allow for inappropriate temperature rises in extreme cases when intense exposure occurs only for a brief period.”

-- NPRM ¶133

FCC's NPRM Approach

Table 1 –Maximum Averaging Times for Device-Based Time Averaging

Frequency (GHz):	<2.9	2.9-7.125	7.125-10.5	10.5-15.4	15.4-24	24-37	37-53	53-95	>95
Time (seconds):	100	49	27	14	7	4	3	2	1

* * * * *

Note: These ranges differ from those currently in use by FCC Lab.

See [Oct TCB Workshop Slide](#)

MWF's Position

- MWF's response to the NPRM urges:
 - MWF advocates specifically that the power density averaging time allowed under the FCC's time-averaging regulations be aligned with the ICNIRP and IEEE standards -- and that its proposed approach (as reflected in Table 5 of the NPRM) be withdrawn.
- MWF's approach is supported by the latest research by Dr. Foster:
 - Dr. Foster notes that the extreme cases being guarded against by the FCC do not occur in telecom signals. We therefore propose that extreme cases be carved out and telecom signals aligned with the IEEE and ICNIRP standards.
 - Dr. Foster advises that if the goal is to protect against excessive thermal transients from extreme high-fluence mm-wave pulses, however unrealistic such exposures may be, a **scientifically accurate approach would be to limit pulse fluence directly**, as an add-on to existing limits and averaging times. This is the approach taken in the latest revisions of IEEE C95.1 (2019) and ICNIRP (2020). A separate NPRM on this approach for extreme cases would be appropriate.

Points for Discussion

- What is the current reason FCC is reluctant to apply the IEEE (or ICNIRP) approach to time averaging for frequencies *below 6 GHz*, in the same way that ISED has already chosen to proceed?
- What is FCC's reasoning with regard to frequencies *above 6 GHz*?
 - Does FCC agree that its concerns revolve around extreme cases?
 - Does FCC agree that regular telecom signals are not a concern?
 - See Dr. Foster's "Big-Bang" signal analysis [here](#).
 - Would FCC consider a carve-out of regular telecom signals for six-minute averaging?

PROPOSAL

- FCC could move forward under the current rulemaking with a rule allowing 6-minute averaging for mobile, terrestrial telecommunications signals.
- For other signals, which will include extreme cases, a further rulemaking could be noticed to determine what averaging period is appropriate.

Specific Questions

- Is FCC accepting SAR reports using the phased array measurement procedures?
- What is the status of PAG series reuse at the Lab?
- Are there plans for dealing with a Gov't shutdown contingency?
- When will there be a shutdown of the equipment authorization system for upgrades?

Certification Streamlining Opportunity

- The FCC Lab previously has identified in [four KDBs](#) the threshold of 0.8 W/Kg as a SAR value below which there is little risk of non-compliance.
- MWF proposes that where a device is measured to be at or below this threshold for consumer devices it is sufficient to certify compliance to the TCB without providing testing detail.
 - Post market surveillance will remain in place
 - EU market surveillance experience indicates low risk of non-compliance
- MWF further proposes that a similar approach be taken for professional devices, where the threshold would be 4.0 W/kg.

BACKUP SLIDES

Dr. Foster's Big-Bang Pulse Analysis [12]

“Big Bang Pulse”: We consider the response to a single pulse of duration $\Delta\tau$ and fluence ($I_0\tau_{\text{avg}}$), which is the maximum fluence pulse permitted under the limit I_0 subject to averaging time τ_{avg} (here assumed to be 6 min). This is the most extreme exposure scenario that would be permitted under the constraints of the limits on time-averaged power density and averaging time.

The thermal transients produced by the “big bang” pulses (Fig. 3) at mm-wave frequencies are as much as 20 times higher than the temperature increases from CW exposure in the steady state. Such “big bang” exposures represent extreme cases that would hardly ever or never be encountered in the real world but are considered as a limiting case. One exception is a military nonlethal weapons system [6].

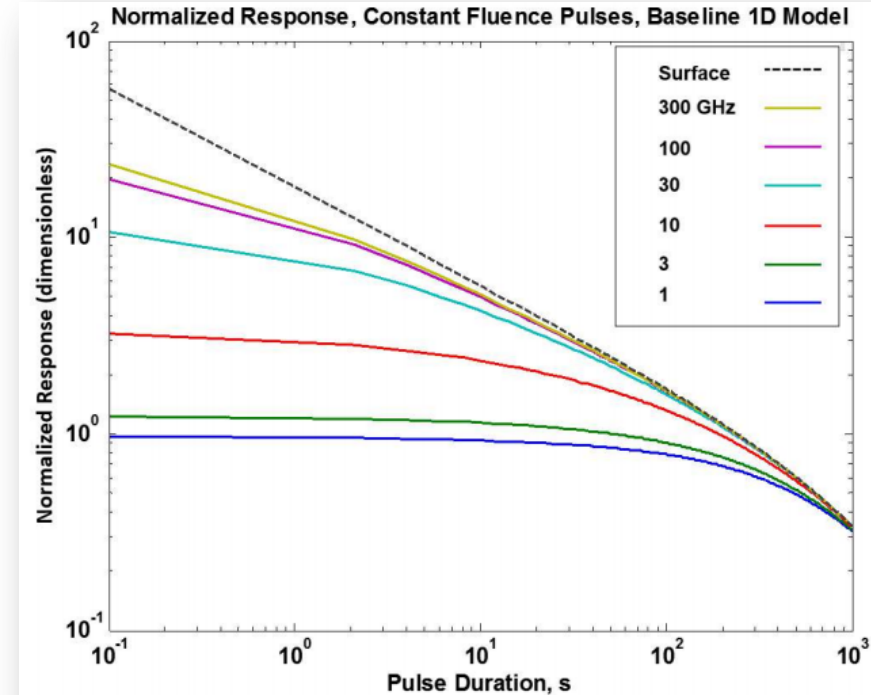


FIGURE 3. Peak transient increase in surface temperature in 1D baseline model produced by a single “big bang” pulse of constant fluence ($I_0\tau_{\text{avg}}$) vs. pulse duration. Results are normalized by the steady-state temperature increase for CW exposures at power density I_0 . Averaging time τ_{avg} is 6 min.

Phased Array Measurement

“Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 3: Vector measurement-based systems (Frequency range of 600 MHz to 6 GHz)”

- IEC 62209-3: 2019

- **KDB 447498 D01 General RF Exposure Guidance v06:**
 - 4.1 h) “Unless it can be demonstrated that..., SAR, and radiating characteristics are the same . . . and the highest reported SAR for the original antenna is $< 0.8 \text{ W/kg}$, similar antennas must be considered separately to determine SAR compliance”;
 - 4.4.1 “Testing of other required channels . . . is not required when the reported SAR . . . for the mid-band or highest output power channel is a) $< 0.8 \text{ W/kg}$;
 - 4.4.2 c) “When the estimated 1-g SAR (fast SAR) of all the test positions required for head SAR measurements ... are all less than 0.8 W/kg , all the test positions can be considered as a single exposure condition”;
 - 5.2.2 b) 1) “When the highest reported 1-g SAR $> 0.4 \text{ W/kg}$ and $\leq 0.8 \text{ W/kg}$, modules and peripheral transmitters may be approved to operate in multiple host platforms”;
- **KDB 865664 D01 SAR Measurement 100MHz to 6GHz v01r04:**
 - 2.8.1. “Repeated measurements are required only when the measured SAR is $\leq 0.80 \text{ W/Kg}$ ”;
- **KDB 941225 D05 SAR for LTE Devices v02r05:**
 - 5.2.1 “When the reported SAR is $< 0.8 \text{ W/kg}$, testing of the remaining RB offset configurations and required test channels is not required for 1RB allocation”;
 - 5.2.3 “For QPSK with 100% RB allocations, SAR is not required when ..., and the highest reported SAR for 1 RB and 50% RB allocation ... are $\leq 0.8 \text{ W/kg}$.”;
- **KDB 248227 D01 802.11 Wi-Fi SAR v02r02:**
 - 5.1.1 “When the reported SAR of the initial test position is $> 0.4 \text{ W/kg}$, SAR is repeated ... in the initial test position using subsequent highest ... 1-g SAR conditions ... until the reported SAR is $\leq 0.8 \text{ W/kg}$...”;
 - 5.2.1 “When the reported SAR of the highest measured maximum output power channel ... for the exposure configuration is $\leq 0.8 \text{ W/kg}$, no further SAR testing is required for 802.11b DSSS ...”;
 - 5.3.3 “When the reported SAR of the initial test configuration is $> 0.8 \text{ W/kg}$, SAR measurement is required for subsequent next highest measured output power channel(s) ...”

From Oct. TCB
Workshop



Interim Guidance for Time Averaging

Interim Guidance	Frequency (GHz)	Maximum Averaging Time (sec)
SAR	< 3	100
	3 – 6	60
MPE	6 - 10	30
	10 - 16	14
	16 – 24	8
	24 – 42	4
	42 – 95	2

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